AMBER model 5500

PROGRAMMABLE AUDIO MEASUREMENT SYSTEM

OWNER'S MANUAL

SECTION 6

MAINTENANCE & CALIBRATION

Issue 07 January 1989

6. CALIBRATION PROCEDURE

CAUTION : This instrument contains CMOS and other types of semiconductors that are sensitive to electrostatic discharge. These parts can be permanently damaged or their reliability diminished unless proper handling procedures are followed.

Before removing the cover of this instrument, study these procedures carefully and follow them rigorously to avoid damaging your instrument.

USE A STATIC-FREE WORK STATION

This includes an antistatic work surface grounded via a high value resistor (330k ohm, for example) to a hard ground. Avoid all plastics, vinyl and styrofoam including styrofoam cups, plastic coffee cups, plastic coffee cup holders, cigarette packages with cellophane wrappers, plastic combs, vinyl books or folders, plastic covers on work sheets, plastic bottles, plastic bags, potato chip bags, plastic purses, plastic solder suckers and plastic ashtrays.

ENSURE THAT YOUR BODY IS GROUNDED BEFORE TOUCHING ANY STATIC SENSITIVE DEVICE

Develop habits to prevent discharging your body into static sensitive devices. When approaching a test bench touch a ground first. When working on equipment, wear a metallic wrist strap connected via a 330k ohm resistor to hard ground. If not wearing a grounding strap, hold on to a ground while touching any semiconductor (unpowered, of course).

USE GROUNDED TEST EQUIPMENT

This includes soldering irons, oscilloscopes, and other instrumentation.

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The model 5500 contains a number of internal calibrations and adjustments. These fall into two categories: Those requiring calibration to an external reference standard and those that are calibrated for best performance.

The 5500 contains a software controlled automatic calibration feature which greatly simplifies the calibration procedure. It can perform most of the AC reference calibrations without the use of an external AC calibrator. This procedure references all AC gains and level measurements to an internal precision DC reference which has a typical accuracy of over an order of magnitude better than the specified AC accuracy of the instrument.

Adjustments for best performance will require an external low distortion generator and external low distortion analyzer. If the instrument contains option 201, High Performance Group, specialized procedures are required to measure the extremely low levels of residual distortion produced. However, if this external equipment is not available, a slightly reduced level of performance can be achieved using only the internal facilities.

All calibrations and adjustments should be done with instrument in a normal temperature and humidity environment (25°C ±3°, 25% ±15%) and nominal AC mains voltage (+5, -10%). The instrument should be powered up with its covers on for at least thirty minutes prior to calibration to ensure that it has reached its normal operating temperature.

6.1 CALIBRATION INTERVAL

The adjustments and calibration procedures described here should be performed every 2000 hours of use or at one year intervals, whichever occurs sooner.

For best performance, it is recommended that the front panel accessed automatic calibration be run as a routine at a frequency comfortable to the user, for example, once per week or prior to sensitive measurements.

6.2 AUTO CAL

The accuracy of all level measurements is a function of the gain accuracy of several programmable gain and attenuation stages, the transfer accuracy of several detectors and the linearity of the analog to digital convertor.

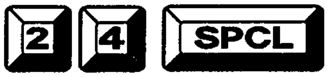
Programmable gain stages and attenuators have inherent accuracy by design to support the system accuracy performance requirements. They use fixed high precision components and do not require calibration.

The other factors that affect system accuracy are calibrated by the AUTO CAL feature. This is done by using a precision internal DC Voltage source as a reference, measuring the transfer gain of the detectors and A to D convertor and storing correction factors in non- volatile memory.

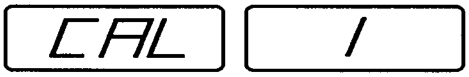
The frequency of the generator is also calibrated at eight points (top and bottom of each decade) against the internal crystal based frequency counter.

The AUTO CAL procedure can be run as often and whenever desired. It is recommended that it be done after the instrument has reached thermal equilibrium (after thirty minutes of powered operation).

To run AUTO CAL, disconnect any cables connected to the OUTPUT A or OUTPUT B (other cables on INPUT, MONITOR, rear panel, etc. can be left in place). Then key in:



You will hear some clicks and the front panel will show



to

as it goes through its multi-step process. The entire sequence takes approximately thirty seconds.

Note: If any hardware failure occurs during the sequence, the display will show:

This is a fatal error indicating that some element of the sequence has experienced a major hardware failure. As almost all of the Generator and Analyzer components are used, the failure could be in several possible locations. Perform diagnostic trouble shooting to locate the failure.

6.3 REQUIRED EQUIPMENT

a) General purpose dual trace, single time base oscilloscope. Bandwidth of 10 MHz or greater.

b) Low distortion generator. Frequency range 10 Hz to 100 kHz. THD + N of generator should be at least 10 dB below (i.e. one third of) the specified distortion of the 5500. Recommended choice: Amber model 3501.

c) Low distortion THD + N analyzer. Frequency range 10 Hz to 100 kHz. THD + N of the analyzer should be at least 10 dB below the specified distortion of the 5500. Recommended choice: Amber model 3501.

OPTIONAL:

d) PROMAG™ extender card. This allows easy access to circuit points on the various analog sub-modules plugged into the 5500 frame. It is available from Amber as 5500 option 701.

e) Digital DC Voltmeter with a resolution of 4.5 digits and an accuracy at 3 V of ± 0.06% or better. (Example, Fluke 8050A)

f) Precision Digital AC Voltmeter with a resolution of 4.5 digits and an accuracy at 1 kHz at 16 V of ± 0.2% (± 0.02 dB). Instruments of this caliber are generally only found in calibration laboratories. In lieu of this, the 5500 instrument's own AC level meter should provide acceptable performance after an AUTO CAL cycle. (Typical accuracy of the above mentioned points will be ± 0.3% (± 0.03dB).)

6.4 INTERNAL ACCESS

Removal of the bottom cover gains access to the power supply board and the connections to the motherboard. Removal of the top cover gains access to all PROMAG™ boards.

In general, calibration of the PROMAG™ boards can be done using an insulated adjustment tool through the labelled holes in the PROMAG™ top brackets which are accessible when the 5500's top cover is removed. Certain calibration steps may require a PROMAG™ extender board (option 701 available from Amber).

6.5 ADJUSTMENT SEQUENCE

In general, the sequence described in the following pages should be strictly followed. Each calibration or adjustment procedure assumes the previous procedures have been completed.

Following is a summary of the categories of adjustments and calibrations, the modules affected and the section numbers of this manual. They are shown in the order to be performed.

TABLE 6.5

ADJUSTMENT & CALIBRATION SUMMARY

SUB-MODULE	PROCEDURE	MANUAL SECTION
Power supply	Vstandby adjustment Vref adjustment +5V adjustment	6.6.1 6.6.2 6.6.2
Oscillator	Frequency calibration THD calibration Level calibration	6.7.2 6.7.3 6.7.4 6.7.5
Detector	Vref calibration	6.8
Preamp (PGA)	CMRR adjustment	6.9
Filter & Notch	Fundamental rejection	6.10.2
PGB & MUX	Weighting filter calibration	6.11
IMD (Option 002)	Level calibration Oscillator IMD adjustment	6.12.1 6.12.2
Auxiliary filters	Audio filter calibration (Option 005)	6.13
Auxiliary filters	Telecom filter calibration (Option 006)	6.14

6.6 POWER SUPPLY

Reference: Power Supply Schematic #11
Motherboard Schematic #16

The 5500 power supply calibration procedure is minimized by virtue of a circuit design which eliminates most trim components. Calibration of the three trimming potentiometers requires an oscilloscope and a precision DC Volt meter.

6.6.1 V-STDBY

The V-STDBY generator provides the supply voltage for the non-volatile RAM resident on the CPU and the charging current for the NICAD batteries.

On the motherboard screw terminal, measure V-STDBY referenced to 0 V (i.e. ground).

Adjust VR8001 to set voltage to 5.00 V DC.

6.6.2 5 VOLTS V-REF ADJUSTMENT

The V-REF trimmer (VR8003) in conjunction with the 5 Volts adjust trimmer (VR8002) sets the switching point of the CPU reset control signal. When V-REF is set, the 5 Volt supply is set to its final value.

Monitor the 5 Volt supply by connecting the voltmeter across D8021 which is located next to the output connector J8008 (cathode of diode is +5 Volts, anode is 0 V). It is important to monitor the 5 Volts directly on the power supply board.

Monitor CPU reset at the connector J416, pin 1 on the motherboard, with the oscilloscope.

Adjust VR8002 (5 V) to 4.85 V.

Adjust VR8003 (V-ref) to minimum (counter clockwise). CPU reset signal should be logic HI (+5 V).

Adjust VR8003 slowly clockwise just until the CPU reset goes to logic LO.

Adjust VR8002 to 5.10 Volts.

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6.7.0 5500 OSCILLATOR BOARD (SVO) CALIBRATION

(Systems without option 201)

The following procedure should be used to calibrate the oscillator board in the system. It assumes that the 5500 system is fully functional and that the 5500 power amp board meets all of its specifications.

This procedure requires an external precision audio analyzer and optionally a precision AC volt meter as described in Section 6.3.

One half hour must be allowed for system warm-up with the cover on so that the system reaches thermal equilibrium. All adjustments are made through numbered holes in the PROMAG™ bracket with the board remaining in its slot. Due to the SVO board's sensitivity to thermal disturbances, all external air currents must be minimized. One effective way to do the following calibration procedure is to replace the 5500 top cover with a cardboard cover that has a slot cut out over the SVO board. This allows adjustment of the trim pots while closely simulating the normal thermal state of the 5500.

6.7.1 SYSTEM SET-UP

Recall machine state 0.1 to initialize the 5500 to a known state.

Enter a source amplitude of 16 Volts and enable output A in 50 ohm unbalanced mode. Enter special function 37.1 for internal source sync. Enter a source frequency of first 100 Hz and then 1 kHz to force the SVO into its range 2 mode.

Connect the 5500 output to the external THD + N analyzer and connect the analyzer's monitors to the oscilloscope.

6.7.2 FREQUENCY SETTING

One frequency adjustment is provided on this module to calibrate the discrete 13th BIT DAC. To make this adjustment, select 500 Hz as the generator frequency. Note the actual reading on the 5500 front panel display then select 1 kHz and adjust #9 for precisely twice the frequency reading as 500 Hz. Example:

SELECT	FREQUENCY DISPLAY
	(example)
500 Hz	500.6 Hz
1 kHz	Adjust for 1001.2 Hz

6.7.3 THD ADJUSTMENT

Step 1 Enter a source frequency of 100 Hz and then 1.0 kHz (oscillator range is now in internal range 2 mode).

Step 2 Adjust #6 and #7 for minimum second harmonic distortion as measured on the external analyzer and oscilloscope.

Step 3 Select a source frequency of 70 kHz. Adjust #4 and #5 to minimize second harmonic distortion.

6.7.4 LEVEL CALIBRATION

Enter a source frequency of 100 Hz and then 1.0 kHz. Select a 50 Ω output source impedance. Connect the 5500 unbalanced output to the precision AC volt meter. With a source amplitude entry of 16.0 Volts, adjust #3 for a reading of exactly 16.000 Volts.

The oscillator is now calibrated and should not be readjusted in the system to compensate any additive system errors.

6.7.5 SQUARE WAVE LEVEL

Select SPCL Function 14.7 to obtain a square wave output. Set generator to +10 dBV, adjust #1 for a 50% duty cycle (equal mark/space ratio) then adjust #2 for a level reading which is the same as the sine wave mode (14.1 SPCL Function).

6.8 DETECTOR

The detector module contains several detectors (rms, average, quasi- peak), a switched gain stage, an analog-to-digital convertor and other circuits. Parameters of all of these circuits affect level measurement accuracy. They are all calibrated using the internal software based automatic calibration sequence (see Section 6.2).

The only external calibration required on this module is the DC Vref precision source used as a reference for all of the AUTO CAL procedures.

The Vref source is factory adjusted and normally will not require calibration by the user. If the AC level measuring accuracy subsequent to an AUTO CAL sequence is suspect, Vref may be measured and, if necessary, adjusted. A DC Voltmeter as described in Section 6.3 should be used.

6.8.1 Vref CALIBRATION

This calibration requires access to circuit board test points thus necessitating the use of the PROMAG™ extender card (Amber 5500 option 701).

Monitor Vref at U4005 pin 1 or P1 pin 36 on the detector module or back plane board.

If the measured DC level is not +3.162 V ± 2mV, adjust VR4003 to the correct value. See Schematic 4E in Section 8.

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6.9 PREAMP CALIBRATION

The preamp is adjusted to optimize CMRR. The following procedure adjusts two trimmers at two frequencies to accurately calibrate the preamp as a system subsection.

It is assumed that the preamp board will be calibrated in a complete and functional 5500. No special instrumentation is required for the procedure. An oscilloscope connected to the input monitor will aid in the procedure to simultaneously observe the common mode waveform while following the calibration steps.

The procedure involves feeding a common mode signal to the differential input of the instrument and adjusting for minimum signal (that is, best CMRR).

To connect a common mode signal, it will be necessary to feed both the tip and ring of the input connector.

Using a telephone type phone plug (WE310 or PJ051), prepare a cable with tip and ring connected together as the "hot" lead from the generator and sleeve as ground. Alternatively, use an Amber banana/binding post to phone plug adapter (Part number 13005).

Step 1 Recall machine state 0.1 to initialize the 5500 to a known state.

Step 2 Set special function 1.8. (This holds the PGA in unity gain.)

Step 3 Set the source amplitude to +10 dBV. Select 50 ohm source impedance, 1 kHz source frequency, select level display in dBV and enable the output.

Step 4 Install the adapter cable into the A input. Jumper the ring- and-tip connections.

Step 5 Connect the source output from the unbalanced BNC connector to the adapter by connecting the commons together and the signal source to the jumpered ring and tip. This presents a common mode signal to the preamplifier.

Step 6 Adjust VR3001, through hole #2, for a minimum reading on the left (level) display.

Step 7 Enter a source frequency of 20 kHz and adjust C3009, through hole #1, for a minimum reading on the left display.

Step 8 Reenter a source frequency of 1 kHz. Repeat both adjustments until no further optimization can be achieved. The level readings at both frequencies will typically be between -70 and -80 dBV.

The preamp is now calibrated and no attempt should be made to adjust it under differing conditions.

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6.10 FILTER & NOTCH (SVF) CALIBRATION

The following procedure should be used to calibrate the filter board in the system. A precision external oscillator with at least 10 dB lower distortion then the 5500 analyzer, such as the Amber model 3501, should be used as the test signal source (see Section 6.3).

6.10.1 SYSTEM SET-UP

Recall machine state 0.1 to initialize the 5500 to a known state and disconnect any inputs or outputs.

Set up the external oscillator to approximately 1.0 kHz and to 3.0 Volts rms level. Connect to the 5500 system INPUT A (unbalanced or balanced input).

Connect the two 5500 front panel monitors to an oscilloscope and display both traces. Select 400 Hz and 30 kHz filters. Enter special function 1.8 (to hold the preamp gain at unity) and select THD mode. You should see the fundamental signal on one trace and the residual distortion on the second trace of the oscilloscope.

6.10.2 ADJUSTMENT

Step 1 Enter a 5500 source frequency of 1000 Hz. Adjust #1 and #2 (VR1001, VR1002) for maximum fundamental rejection.

The filter and notch board is now calibrated.

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6.11 PGB MUX CALIBRATION PROCEDURE

The following calibration procedure applies to the weighting filters located on the PGB board. The PGB circuitry itself does not have adjustments. And only one of the three trimmers in the weighting filters group is adjusted, depending on which filter has been installed (ANSI/IEC A is standard, CCIR [option 101] or Psophometric [option 102] is optional).

It is assumed that the following adjustments are done in a complete and otherwise functional and calibrated 5500.

6.11.1 INSTRUMENT SET-UP

Recall machine state 0.1 to initialize the 5500 to a known state.

Request a generator source amplitude of 0 dBV (1 V), enable OUTPUT A and select OSCA as the INPUT. Select log units (i.e. dBV or dBm) and set a relative level of 0.0 dB by pushing SHIFT and RELATIVE. This is the reference level with no filters selected. Also select 37.1 SPCL FNCT for oscillator sync since certain levels during the course of this procedure may be below that required for proper frequency measurement.

All adjustments can be made without removing the PGB board from its slot. Each adjustment is accessible through labelled holes in the PGB PROMAG™ bracket. The 5500 level display (left display) along with an oscilloscope connected to the input and measured function monitors is all that is required. Allow several minutes for system warm-up with the cover on.

The following procedure adjusts the gain of the weighting filter to conform to the reference standard. This is done by setting the gain to unity at a particular frequency. Unity gain is verified by turning the filter off and on and noting no level change when the test generator is at the reference frequency.

6.11.2 PGB WITH "A" WEIGHTING FILTER (standard)

Observe the measured level. Select A-WTG filter and observe the measured function monitor for any problems.

Adjust R7001 through hole #1 to match the reference level (0.0dB) at a source frequency of 1kHz (unity gain).

6.11.3 PGB WITH CCIR FILTER (option 101)

Set source frequency to 1 kHz for the original CCIR specification or to 2 kHz for the Dolby specification. Observe the measured level.

Select CCIR, observe the measured function monitor for any problems and adjust VR7002 through hole #2 for unity gain (0.0 dB).

6.11.4 PGB WITH PSOPHOMETRIC (option 102)

Set source frequency to 800 Hz and observe the measured level. Select psophometric, observe the measured function monitor for any problems and adjust VR7003 through hole #3 for unity gain (0.0 dB).

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6.12.0 IMD CALIBRATION
(if option 002 is installed)

The following procedure should be used to calibrate the IMD board. This requires a complete and functional 5500 system where the standard (non-optional) subsections of a 5500 system have been factory calibrated or user calibrated in the correct sequence as described in Section 6.0.6.

The three adjustments on the IMD pertain to the oscillator section and are adjusted using only an oscilloscope. There are no adjustments in the analyzer section.

Allow one half hour for system warm-up with the cover on. The adjustments should be done through the holes in the PROMAG™ bracket instead of on the extender card. This will keep the board temperature more stable. Note that the CCIF adjustments are the most temperature dependent and may require readjustment after replacing the cover on the 5500 for five minutes.

6.12.1 LEVEL CALIBRATION

Step 1 Recall machine state 0.1 to initialize the 5500 to a known state. Disconnect any inputs or outputs.

Step 2 Set special function 1.8. (This holds the PGA in unity gain.)

Step 3 Select source amplitude to 3.00 V rms. Select 50 ohm source impedance, enable the output and select oscillator A send on the input select. Connect the unbalanced 50 ohm output to an oscilloscope.

Step 4 While in level mode, adjust the variable gain of the oscilloscope to have the sine wave signal displayed occupy six vertical divisions peak-to-peak. This sets a reference displayed amplitude.

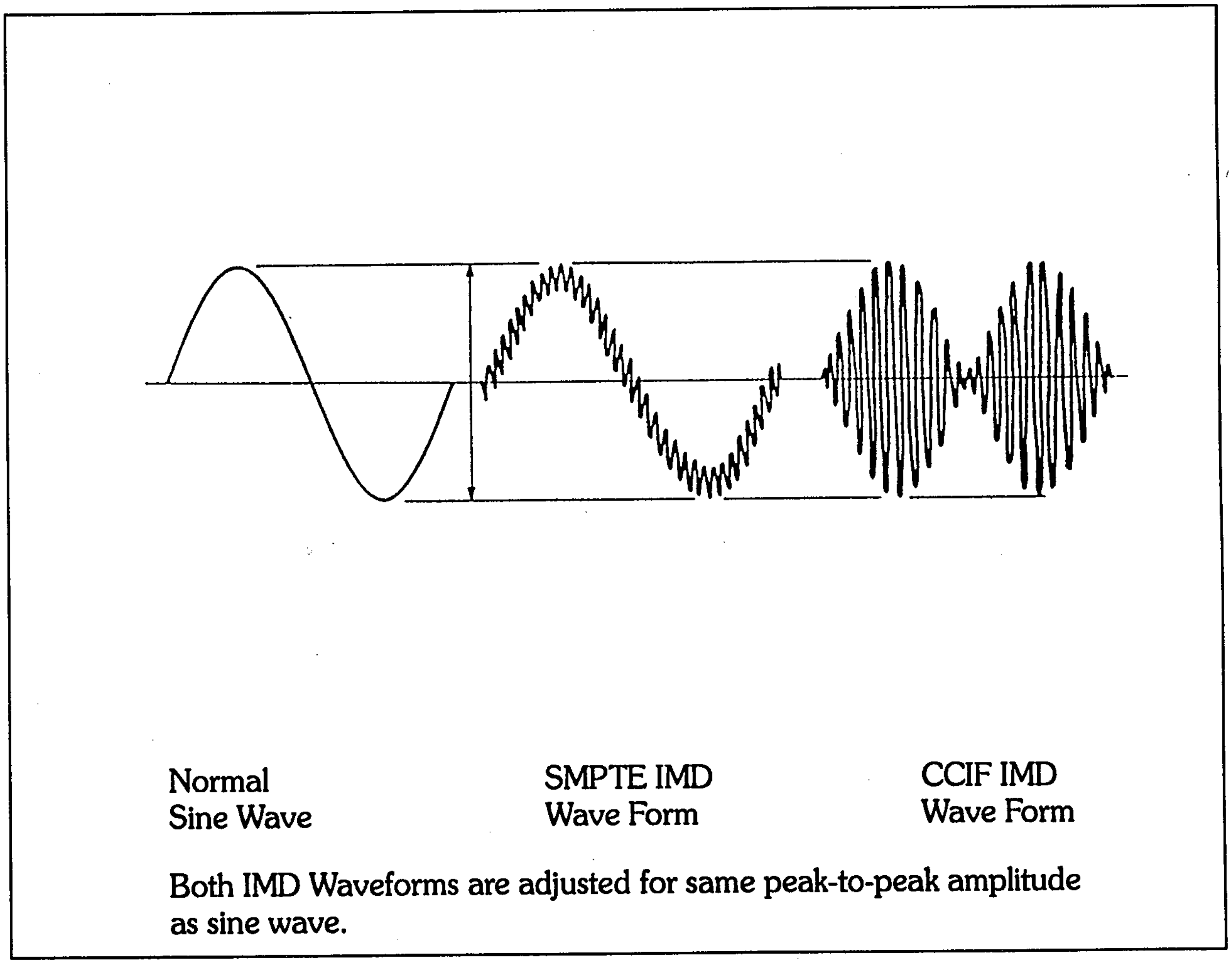
Step 5 Select SMPTE IMD mode. Adjust VR6003, through hole #3, so that the SMPTE signal is also six vertical divisions peak-to-peak on the oscilloscope.

Step 6 Select CCIF IMD mode. Adjust VR6002, through hole #2, so that the CCIF signal is also six vertical divisions peak-to-peak on the oscilloscope.

6.12.2 DISTORTION ADJUSTMENT

While in CCIF mode, select a LF frequency of 500 Hz and a HF frequency of 100 kHz. Connect the oscilloscope to the measured function monitor of the 5500. Adjust VR6001, through hole #1, for minimum IM distortion.

Replace the cover on the system and verify the adjustments after five minutes. This completes the IMD calibration.



Both IMD Waveforms are adjusted for same peak-to-peak amplitude as sine wave.

Fig. 6.12 IMD Test waveforms

6.13 AUDIO WEIGHTING FILTER (Option 005)

This module provides four audio noise weighting filters meeting various international standards. Two of the four filters have a unity gain adjustment. One filter has a notch frequency adjustment and one filter has no adjustment.

6.13.1 5500 SET UP

Recall machine state 0.1 to initialize the 5500 to a known state.

Request a generator source amplitude of 0 dBV (1 V), enable OUTPUT A and select OSCA as the INPUT. Select log units (i.e. dBV or dBm) and set a relative level of 0.0 dB by pushing SHIFT and RELATIVE. This is the reference level with no filters selected. Also select 37.1 SPCL FNCT for oscillator sync since certain levels during the course of this procedure may be below that required for proper frequency measurement.

6.13.2 CALIBRATION OF CCIR FILTER

Enter a source frequency of 2 kHz if the Dolby specification is used or enter a source frequency of 1 kHz if the original CCIR 468-3 specification is used.

Observe the level reading and then select CCIR filter. Adjust VR8003, through hole #4, to match the level reading observed before (0.0 dB).

6.13.3 CALIBRATION OF ANSI/IEC A WEIGHTING FILTER

Deselect CCIR and enter a source frequency of 1 kHz. Observe level reading. Select the "A" weighting filter. Adjust VR8002, through hole #3 for the reference reading (0.0 dB).

6.13.4 CALIBRATION OF IHF WEIGHTING FILTER

Enter a source frequency of 19 kHz. Using the modify up/down buttons and using a suitable frequency increment value, set the source frequency to 19.000 kHz, ±9 Hz. Select the IHF filter. Repeatedly adjust both C8062 and VR8001, through holes #1 and #2, for the maximum attenuation possible in the 19 kHz notch circuit. Note that the notch may require further trimming after the board achieves a stable temperature when the 5500 cover is replaced.

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6.14 TELECOMMUNICATIONS WEIGHTING FILTERS (Option 006)

This module contains four noise weighting filters, two band pass and two low pass. The low pass filters have unity pass band gain by design and precision frequency determining components. They have no adjustments. The two band pass filters have gain adjustments and the C-Message also has notch frequency adjustment.

6.14.1 5500 SET-UP

Recall machine state 0.1 to initialize the 5500 to a known state.

Select source amplitude of 0 dBV, enable output A, select oscillator send A on the input selector and select dBV units for the level display. Also enter special function 37.1 to set internal sync.

6.14.2 PROGRAM FILTER CALIBRATION

With source frequency at 1 kHz, set a relative level of 0.0 dB by pushing SHIFT and RELATIVE while in the log units. Select the Program filter. Adjust VR8003, through hole #4, for the same 0.0 dB level.

6.14.3 C-MESSAGE FILTER

The C-Message filter consists of a multi-pole band pass section and a nominal 1 kHz notch (band reject) section. Adjustments to the filter require bypassing specific sections as described below.

The notch facility is implemented by cascading three separate notches at 995 Hz, 1010 Hz and 1025 Hz to achieve broad frequency width and deep notch depth. Each notch filter has a center frequency adjustment and each must be set independently.

The band pass section has a gain adjustment that must be set for unity gain at 1 kHz. To allow this adjustment to be set, the three notch filters must be bypassed.

The input and output of each notch filter appears on a PCB post. these are arranged in such a manner that 0.1 inch jumper plugs are used to connect each filter in the path in the normal mode. The filters can be easily bypassed or reconfigured by removing these jumpers and using miniature clip leads or jumper wires with post sockets.

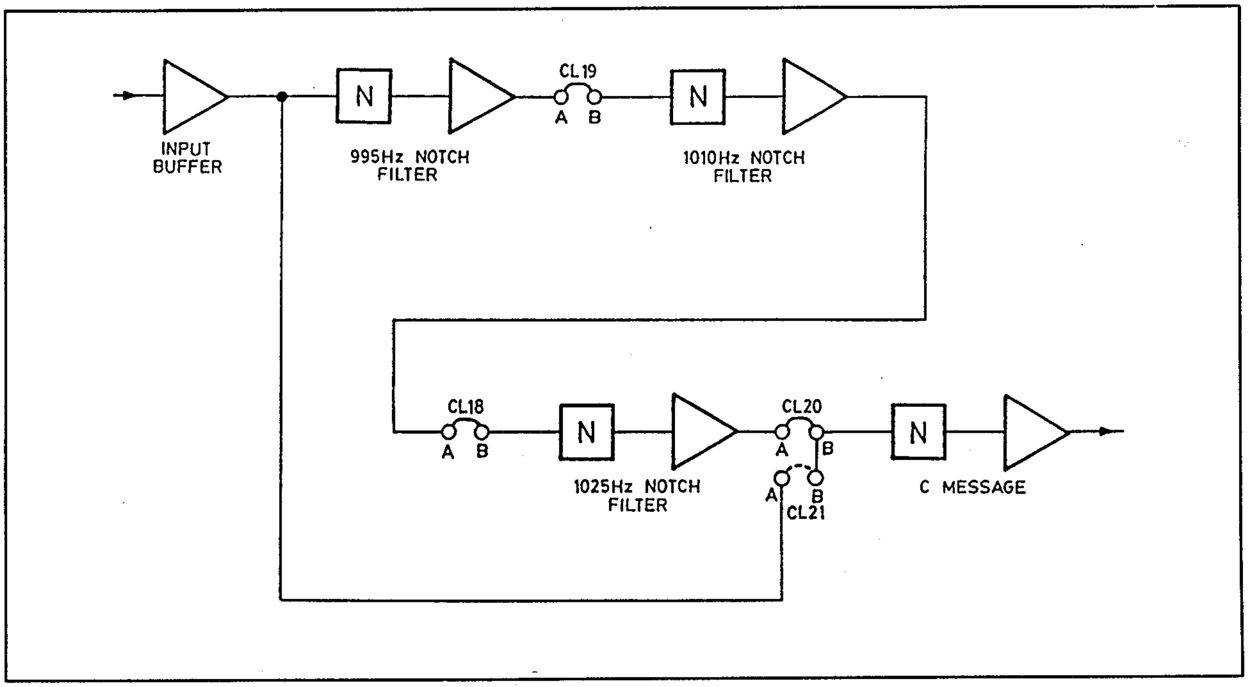

Fig. 6.14.1 Notch filter functional path

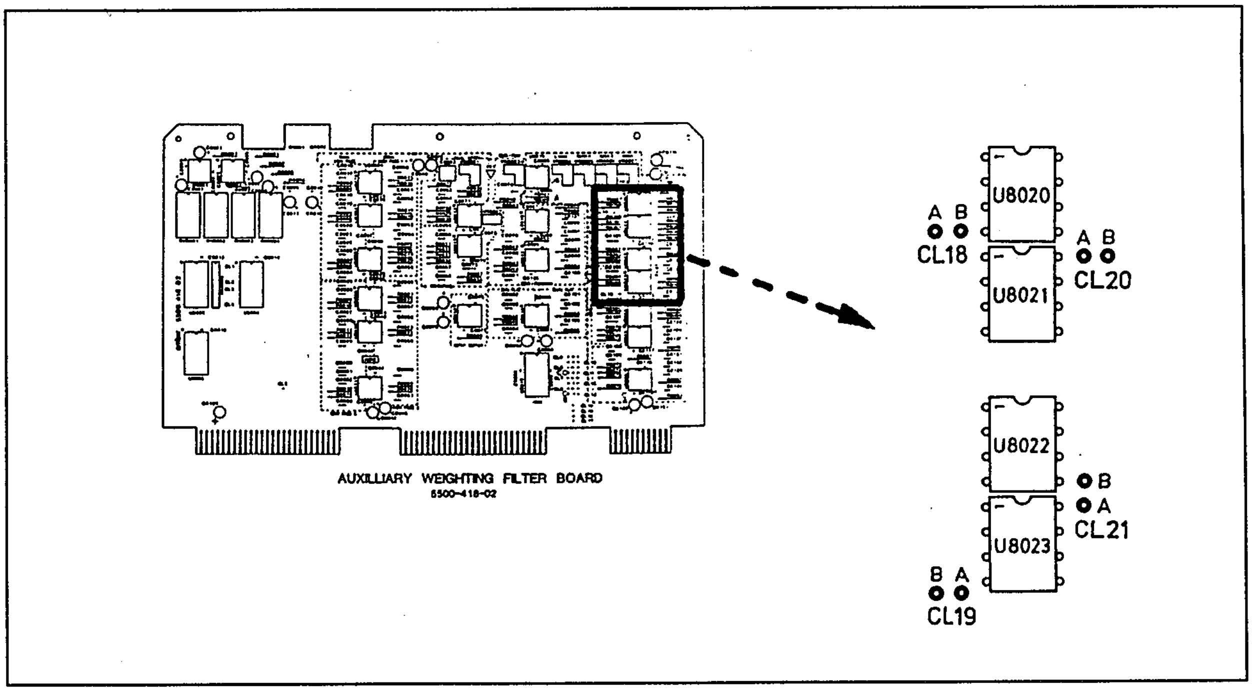

Fig. 6.14.2 Notch filter jumper locations

TABLE 6.14.1 NOTCH FILTER JUMPERS		
FILTER	**INPUT**	**OUTPUT**
995Hz	Internal	CL19-A
1010Hz	CL19-B	CL18-A
1025Hz	CL18-B	CL20-A
C-Message	CL20-B Internal	CL21-B
Input signal	CL21-A	——

TABLE 6.14.2 JUMPER CONFIGURATIONS	
DESIRED PATH	INSTALL JUMPER
C-Message ONLY	CL21-A to CL21-B
995Hz Notch	CL19-A to CL21-B
1010Hz Notch	CL21-A to CL19-B and CL18-A to CL20-B
1025Hz Notch	CL21-A to CL18-B and CL20-A to CL20-B
NORMAL OPERATION	CL19-A to CL19-B CL18-A to CL18-B CL20-A to CL20-B

6.14.4 C-MESSAGE GAIN

Bypass the three notch filters by removing all jumpers and connecting CL21-A to CL21-B (see Table 6.14.2).

Step 1 Recall machine state 0.1 to initialize the 5500 to a known state.

Select source amplitude of 0 dBV, enable output A, select oscillator send A on the input selector and select dBV units for the level display. Also enter special function 37.1 to set internal sync.

Step 2 With a source frequency of 1 kHz, set a relative level of 0.0 dB by pushing SHIFT RELATIVE while in the log units mode. Select the C-Message filter and adjust VR8004 through hole #5 for the same 0.0 dB level.

6.14. NOTCH FREQUENCY TUNE

Each of the three notch filters will be fine tuned for its nominal center frequency. Each is connected in the path one at a time while the other two are bypassed. (Note that the C-Message filter remains in the path for these adjustments.)

Connect an oscilloscope to the MEASURED FUNCTION MONITOR output. This will allow the observation of the filter tune null described below. The level meter on the 5500 will under-range near null making accurate tuning difficult but the external oscilloscope (or an external level meter) will facilitate this adjustment.

Step 1 Install the 995 Hz notch filter in the path by connecting jumpers CL19-A to CL21-B (see Table 6.14.2).

Step 2 Select a source frequency of 995 Hz ± 1 Hz (use the increment mode to fine tune the oscillator).

Step 3 Adjust VR8005 through hole #6 for maximum attenuation (i.e. minimum signal).

Step 4 Install the 1010 notch filter in the path by connecting CL21-A to CL19-B and CL18-A to CL20-B.

Step 5 Select a source frequency of 1010 Hz ± 1 Hz.

Step 6 Adjust VR8006 through hole #7 for maximum attenuation.

Step 7 Install the 1025 Hz notch filter in the path by connecting jumpers CL21-A to CL18-B and CL20-A to CL20-B.

Step 8 Select a source frequency of 1025 Hz ± 1 Hz.

Step 9 Adjust VR8007 through hole #8 for maximum attenuation.

Step 10 Reconnect the filter path to normal operation by connecting jumpers CL19-A to CL19-B, CL18-A to CL18-B and CL20-A to CL20-B.

This completes the C-Message and notch adjustments.